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PHYSICAL FITNESS OF MARINE CORPS RECRUITS

Timothy E. Rupinski

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Timothy E. Rupinski

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ABSTRACT

The Marine Corps views the physical fitness of every Marine as essential to its overall effectiveness. This research memorandum reviews the Physical Fitness Test (PFT), estimates the effect of height and weight measures on the PFT scores of recruits, assesses the need for minimum and maximum weight standards, and forecasts the impact of alternative accession standards on physical fitness.

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EXECUTIVE SUMMARY

The Commandant of the Marine Corps requested that CNA examine both accession and active duty weight standards to determine whether they can be made equitable and appropriate for men and women without lowering quality standards. This research memorandum examines the effect of changing the accession weight standards on physical fitness. The impact of alternative height-weight standards on other measures of manpower quality, such as first-term attrition, will be addressed in forthcoming memorandums.

DATA AND METHODOLOGY

Because differences in the test between genders prevent the estimation of the effect of gender on physical fitness, the effect of height and weight measures on PFT scores was analyzed separately for each gender. The sample of Marines consists of non-prior-service recruits who were accessed from FY 1982 through FY 1987. For each gender, the first PFT score was estimated as a function of height and weight controlling for age, race, time elapsed from the start of training to the test date, and a time trend based on the fiscal year in which the recruit was accessed.

To facilitate the comparison of different weights across different heights, height and weight were translated into a valid, widely accepted measure called body mass for each gender. Body mass was then expressed in percentiles using civilian data on 20- to 29-year-olds from each gender as the norm. Higher body masses or percentiles of body mass are associated with higher weights for a given height and gender. Alternative specifications of the model were then estimated that substituted body mass or percentiles of body mass for the height and weight variables.

Maximum weight standards were evaluated in terms of their predicted effect on physical fitness. In addition to the current accession and active duty standards of the Marine Corps, standards proposed by the National Center for Health Statistics (NCHS), the Defense Manpower Data Center (DMDC), and the Naval Health Research Center (NHRC) were considered.

CONCLUSIONS

Linear regression analysis showed that PFT scores generally decline with increases in body mass or weight for both genders. Scores are maximized below the 50th percentile (e.g., average civilian weight for a given height). The decline in physical fitness with respect to body mass over the middle and upper end of the distribution justifies the use of a maximum weight standard.

Relative to Marines in the first to fifth percentiles of body mass, significant reductions in physical fitness were not observed until the 61- to 65-percentile group for males and the 26- to 30-percentile group for females. Because neither of those groups would be classified as overweight under any of the proposed standards, average fitness in the bottom five percent of body mass is better than that in percentile groups that are acceptable under any of the standards. Based on physical fitness, minimum weight standards could be lowered slightly with a continuation of the present waiver policies.

Tables I and II show the predicted PFT scores (on a scale of 300) and their respective PFT class (first class requires a minimum score of 225 for males and 200 for females) by gender. The scores are predicted at about six months into the first term for a 20-year-old Marine of median height who is accessioned at the maximum weight of each standard. The tables show how maximum weight standards corresponding to higher percentiles of body mass create a larger pool of potential recruits at the cost of a lower level of physical fitness. If a first class PFT score is desired for the typical Marine at the maximum weight, the accession weight standards should be no greater than the 95th percentile for males (NCHS standard for severely overweight males) and the 80th percentile for females (adjusted NCHS standard for overweight females).

In selecting the appropriate maximum weight standard, policymakers should consider the tradeoff between physical fitness and applicant eligibility. The estimated magnitude of this tradeoff may be biased downward because unsatisfactory PFT scores were never observed in the data. The size of this bias will be larger to the extent that Marines who would receive unsatisfactory scores do not have those scores recorded, retake the PFT until they receive a satisfactory score, or separate before taking the test.

Direct comparisons of physical fitness across genders are infeasible because males and females are given different tests. The Army and Navy use the same test for both genders but subject males to stricter standards. If physical fitness is to be compared across genders, the Marine Corps could adopt one of these other tests. Using the same test as other services does not preclude the Corps from establishing its own minimum standards of physical fitness.

Table I. Effect of maximum weights on physical fitness (20-year-old males at median height of 69 inches)

Standard	Maximum weight (pounds)	Corresponding percentile of body mass	Predicted PFT score at maximum weight	Class
NHRC 22% body fat (Navy active duty)	182	80	236.4	1st
Marine Corps active duty	186	84	235.0	1st
NCHS (overweight)	188	85	234.3	1st
DMDC (120% of mean body mass)	192	88	232.9	1st
NHRC 26% body fat (Navy accession)	203	92	229.1	1st
Marine Corps accession	209	95	227.0	1st
NCHS (severely overweight)	210	95	226.6	1st
NHRC age-adjusted 26% body fat	219	97	223.5	2nd

Table II. Effect of maximum weights on physical fitness (20-year-old females at median height of 64 inches)

Standard	Maximum weight (pounds)	Corresponding percentile of body mass	Predicted PFT score at maximum weight	Class
Marine Corps accession	138	66	213.1	1st
Marine Corps active duty	138	66	213.1	1st
NHRC 30% body fat (Navy active duty)	145	75	207.2	1st
Adjusted NCHS (overweight)	152	80	201.4	1st
DMDC (120% of mean body mass)	157	84	197.2	2nd
NCHS (overweight)	159	85	195.5	2nd
NHRC 36% body fat (Navy accession)	166	89	189.6	2nd
NHRC age-adjusted 36% body fat	167	89	188.8	2nd
Adjusted NCHS severely overweight	170	90	186.2	2nd
NCHS (severely overweight)	189	95	170.3	2nd

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INTRODUCTION

The Commandant of the Marine Corps requested that CNA examine both accession and active duty weight standards to determine whether they can be made equitable and appropriate for men and women without lowering quality standards. One important measure of manpower quality is physical fitness. The emphasis on physical fitness is intended to improve not only combat readiness but also day-to-day performance of duties, leadership, and self-discipline [1]. The goals of this research memorandum are to review the Physical Fitness Test (PFT), to determine whether the use of minimum and maximum weight standards can be justified based on physical fitness, and to predict the relative effects of alternative accession standards on PFT scores.

The next section describes the Marine Corps' PFT and contrasts it with tests used by the Army and the Navy. The remaining sections describe the data used in the analysis, develop and estimate models of the determinants of PFT performance, compare alternative height-weight standards, and show the implications of these standards on physical fitness.

PHYSICAL FITNESS TESTS

The PFT is required semiannually for all Marines under the age of 46 years, except for those on duty in a combat zone or receiving a medical waiver. It consists of three events with a maximum of 100 points per event for a total of 300 points.

Different tests are given to males and females. The male PFT consists of sit-ups (2 minutes), pull-ups (no time limit), and a three-mile run. For females, the events are sit-ups (1 minute), a flexed-arm hang (no time limit), and a 1.5-mile run. Table 1 briefly summarizes the point system at 10-point intervals.¹ Because each gender has a different test of upper body strength (i.e., pull-ups for males and flexed-arm hang for females), the relative level of difficulty cannot be determined for a given number of points. Such comparisons can be made, however, for the sit-ups and running.

For the same point total, table 2 demonstrates that males must average fewer minutes per mile in the 3-mile run than females must average in the 1.5-mile run. Any person should average fewer minutes per mile for a shorter distance, so the same score on the run test translates into a higher level of performance for males than for females. In the case of the sit-up test, both genders must average the same number of sit-ups per minute in obtaining scores of 60 points or less. Because males have a longer test, a score of 60 points or less represents a higher level of performance for males than the same score for females. Above 60 points, females must average more sit-ups per minute. However, because the time of the sit-up test is shorter for

1. Reference [1] describes the PFT in greater detail.

Table 1. PFT scoring system

Points	Males			Females		
	Pull-ups	Sit-ups	3-mile (min:sec)	Flexed-arm hang	Sit-ups	1.5-mile run
100	20	80	18:00	1:10	50	10:00
90	18	75	19:40	1:05	45	10:50
80	16	70	21:20	1:00	40	11:40
70	14	65	23:00	:55	35	12:30
60	12	60	24:40	:50	30	13:20
50	10	50	26:20	:45	25	14:10
40	8	40	28:00	:40	20	15:00
30	6	30	29:40	:30	15	15:50
20	4	20	31:20	:20	10	16:40
10	2	10	33:00	:10	5	18:00

Table 2. Comparison of components of PFT test by gender

Points	Sit-ups per minute			Minutes per mile		
	Female	Male	Difference	Female	Male	Difference
100	50.0	40.0	10.0	6:40	6:00	:40
90	45.0	37.5	7.5	7:13	6:33	:40
80	40.0	35.0	5.0	7:47	7:07	:40
70	35.0	32.5	2.5	8:20	7:40	:40
60	30.0	30.0	0.0	8:53	8:13	:40
50	25.0	25.0	0.0	9:27	8:47	:40
40	20.0	20.0	0.0	10:00	9:20	:40
30	15.0	15.0	0.0	10:33	9:53	:40
20	10.0	10.0	0.0	11:07	10:27	:40
10	5.0	5.0	0.0	12:00	11:00	1:00

females than males, it is ambiguous as to which gender has the more difficult test for scores above 60 points.

In general, it is uncertain which gender has the higher level of performance for the same total point score from the three tests. The infeasibility of contrasting sit-up scores above 60 points across genders and comparing pull-up scores with flexed-arm hang scores is responsible for this uncertainty. Moreover, the different time limits on the sit-up tests and different distances in the run tests preclude estimating the magnitude of differences in physical fitness between genders.

These problems could be addressed by giving both males and females the same physical fitness test but subjecting males to stricter standards than females. Both the Army and the Navy use tests that satisfy this criterion. The Army's Physical Readiness Test (APRT) consists of a stretch test, 2-mile run, 2 minutes of push-ups, and 2 minutes of sit-ups. The Navy's Physical Readiness Test (PRT) consists of a sit-reach test, 1.5-mile run or 500-yard swim, 2 minutes of push-ups, and 2 minutes of sit-ups. For both genders, each of these services not only uses the same test but also the same point system, enabling comparisons of physical fitness scores across genders. The test standards are then adjusted for both age and sex.¹

In reference [4], several measures of physical fitness were validated against specific measures of job performance by the Naval Health Research Center (NHRC). That study was based on a sample of 102 active duty naval personnel ranging in age from 20 to 35 years. The tasks used to measure job performance included box-carrying and box-lifting. In the box-carrying task, the subject was required to carry a 34-kilogram box on a 51.4-meter course as many times as possible. Performance was measured by the total distance covered in two 5-minute tests, allowing for a 1-minute rest between tests. The box-lifting task required the subject to lift boxes of varying weights from the floor to a platform at elbow height with a 1-minute rest between each attempt. Performance was measured by the maximum weight lifted during the test.

Table 3 reproduces some of the main results of the NHRC analysis. Higher performances on the push-up, pull-up, sit-up, and running tests are positively correlated with box-carrying power (weight \times distance/second). Higher performances on the push-up, pull-up, and running tests are also positively correlated with maximal box-lifting (weight). Of these tests, running is the best predictor of carrying performance, whereas tests of upper body strength (push-ups or pull-ups) are the best predictors of lifting performance. The correlation coefficients for push-ups and pull-ups with a given task are virtually identical, implying that the Marine Corps could substitute a push-up test for

1. The Physical Readiness Tests of the Army and the Navy are described in more detail in [2] and [3], respectively. The Air Force's test is not comparable to that of the other services because it consists solely of a 1.5-mile run or 3-mile walk.

its pull-up test without changing the basic meaning of the test. This finding is further supported by the high correlation coefficient (0.82) between push-ups and pull-ups. The relatively low correlation coefficients between the sit-reach test and either the box-carrying or box-lifting tasks suggests that it fails to effectively predict job performance as measured by these criteria.

Table 3. Test validation by Naval Health Research Center

Test	Test measure	Correlation coefficient of test measure with:	
		Box carry power	Maximal box lift to elbow height
Push-ups	Number in one minute	.56 ^a	.63 ^a
Pull-ups	Maximum number	.55 ^a	.62 ^a
Sit-ups	Number in two minutes	.31 ^a	.00
1.5-mile run	Completion time in seconds	-.67 ^a	-.34 ^a
Sit-reach	Reach length relative to end of toes in centimeters	.01	-.21 ^b

SOURCE: [4, p. 21].

a. Indicates statistical significance at the 1-percent level.

b. Indicates statistical significance at the 5-percent level.

DATA AND METHODOLOGY

The Automated Recruit Management System (ARMS) is the primary source of data for the analysis. The sample consists of non-prior-service Marine recruits who were accessed from FY 1982 through FY 1987. Gender, age, height, weight, and race were among the variables extracted from ARMS. PFT scores were obtained from the Headquarters Master File (HMF) over this period. The final sample consists of 113,332 males and 7,151 females ranging in age from 17 to 30 years.

Because Marines should be receiving new scores semiannually, their first PFT score was chosen as the dependent variable in the analysis. The rationale for this choice is that only the initial weights upon entry to the service were available. To reduce the measurement error associated with using the initial weight rather than the unknown weight at the time of the PFT, the difference between the date of the PFT and the initial training start date is minimized by selecting the first PFT score. Marines were included in the sample only if they had a PFT score in their first year of service.

Table 4 shows the distribution of PFT scores for 17- to 26-year-old recruits who make up 99.3 percent of the male sample and 97.8 percent of the female sample. The scores are grouped in terms of the classification scheme used by the Marine Corps. The percentage distributions between the four categories are quite similar for males and females. Over 70 percent of the recruits receive scores corresponding to the first class, and no one receives an unsatisfactory score. The potential for censored data at the upper end of the distribution is rather small because only 1.9 percent of the males and 0.6 percent of the females receive perfect scores of 300. However, the fact that the minimum score observed for males (135) and females (100) in the sample is equal to the minimum score required for satisfactory performance suggests that Marines who would receive unsatisfactory scores do not have those scores recorded, retake the PFT until they receive a satisfactory score, or separate before taking the test. To the extent that these events occur, the effect of weight on the PFT score will be underestimated by the regression model.

Table 4. Classification of PFT scores

Category	Male		Female	
	Scores	Percent	Scores	Percent
1st Class	225-300	72.8	200-300	71.4
2nd Class	175-224	23.0	150-199	23.7
3rd Class	135-174	4.2	100-149	4.9
Unsatisfactory	0-134	0.0	0-99	0.0

The basic model regresses the PFT score on a height-weight measure controlling for several other independent variables, which are defined in table 5. Four different specifications of the model are estimated using different height-weight measures. In the first specification, height and weight are entered as separate variables. The second specification combines height and weight into a single measure called body mass. Higher values of body mass are associated with higher weights for a given height and gender. Body mass is defined as weight in kilograms divided by height in meters with height raised to a power of 2 for males and 1.5 for females. The exponent of height is the elasticity of weight with respect to height (i.e., the estimated percentage change in weight divided by a given percentage change in height) using civilian data. It differs between genders because of differences in the distribution of weights and heights. The validity of these particular measures of body mass is documented in [5] and [6].

Table 5. Definitions of independent variables

Variable	Definition	Model specification
Weight	Weight in pounds	(1) only
Height	Height in inches	(1) only
Body mass	Males: $\frac{\text{weight in kilograms}}{(\text{height in meters})^2}$ Females: $\frac{\text{weight in kilograms}}{(\text{height in meters})^{1.5}}$	(2) only
Percentile	Percentile of body mass based on 20- to 29-year-old civilian sample from each sex	(3) only
P(i to j)	1: body mass within the ith to jth percentiles inclusive 0: otherwise	(4) only
Age	Age in years at time of PFT	(1), (2), (3), (4)
Race	1: white 0: otherwise	(1), (2), (3), (4)
Nmonths	Number of months between PFT date and original training start date	(1), (2), (3), (4)
Time	Number of fiscal years between original training start date and FY 1982	(1), (2), (3), (4)

In the third specification, body mass is converted into percentile terms for each gender using civilian data from the second National Health and Nutrition Examination Survey (NHANES II). NHANES II was conducted by the National Center for Health Statistics (NCHS) during 1976 through 1980.¹ Because NCHS uses the body masses of 20- to

1. Reference [7] discusses the methodology used in the survey and provides summary statistics from the data base. NCHS assumes responsibility only for the data and not for any analysis, interpretations, or conclusions contained in papers using their data base.

29-year-old youth as its reference group in defining overweight, the percentiles are constructed separately for each gender based on the body masses of this age group. If a Marine has a body mass in the 85th percentile, it would imply that 85 percent of the civilian population in the 20- to 29-year-old age group of his or her gender have lower body masses. Higher percentiles of body mass are associated with higher weights for a given height and gender. Appendix A lists the values of body mass corresponding to each percentile.

In comparing alternative height-weight standards, it is necessary to determine whether the effect of underweight on physical fitness is similar to the effect of overweight. The fourth specification of the model addresses this issue by employing 19 dummy variables for percentiles of body mass. Each of these variables corresponds to five percentile points in body mass ranging from 6-10 to 96-100 for males and from 6-10 to 71-75 for females. Marines in percentiles 1 through 5 are the reference group for each gender. For example, the coefficient of the dummy variable, P(51 to 55), in the PFT regression equation would represent the estimated difference in physical fitness between Marines in the 51st to 55th percentile group and Marines in the 1st to 5th percentile group.

Each of the four regression equations controls for age, race, and two measures of time. The time between the PFT test and the beginning of training (Nmonths) measures both changes in PFT performance during the first year in the Marine Corps and the tendency for physically unfit personnel to delay taking the PFT. Because the sample begins in FY 1982, the time between the beginning of training and the beginning of the sample period (Time) measures whether recruits of more recent vintage perform better than recruits of earlier vintages.

REGRESSION RESULTS

Each regression equation was estimated using ordinary least squares. Tables 6 and 7 present the results of the analysis for males and females, respectively. With the exception of the age variable in some of the male regressions, each coefficient is statistically significant at the .01 level. Based on the F-statistics, each equation is also statistically significant at the .01 level. The rather large t-statistics and F-statistics for the male sample are due in part to the high degree of precision in estimating coefficients using such a large sample.

Each of the variables, with the exception of Age, has the expected sign on its coefficient. Age has a small but consistently positive effect on physical fitness but only for a limited range of ages. To put

Table 6. Male regression results (dependent variable: PFT score)

Independent variable ^a	Mean (SD)	Coefficient (t-statistic)			
		(1)	(2)	(3)	(4)
Intercept		284.4 (93.1)	305.7 (217.3)	262.7 (208.6)	254.3 (196.2)
Weight	159.1 (23.7)	-.35 (-67.4)			
Height	69.2 (2.7)	.27 (6.1)			
Body mass	23.3 (3.0)		-2.3 (-65.7)		
Percentile	43.5 (27.5)			-.24 (-61.4)	
P(i to j)					Shown in table 9
Age	.9.9 (1.7)	.21 (3.4)	.10 (1.5)	.06 (.9)	.04 (.6)
Race	.76 (.43)	-5.4 (-21.9)	-6.2 (-25.1)	-6.2 (-25.1)	-6.1 (-24.9)
Nmonths	6.0 (3.4)	-1.3 (-41.9)	-1.3 (-41.4)	-1.3 (-41.4)	-1.3 (-41.3)
Time	2.4 (1.6)	2.0 (29.7)	1.8 (27.5)	1.8 (27.3)	1.8 (27.6)
R ²		.07	.06	.06	.08
F-statistic		1,504.2	1,560.0	1,447.5	420.1

NOTE: Mean and standard deviation of PFT score are 245.4 and 36.4, respectively.

a. The independent variables are defined in table 5.

Table 7. Female regression results (dependent variable: PFT score)

Independent variable ^a	Mean (SD)	Coefficient (t-statistic)			
		(1)	(2)	(3)	(4)
Intercept		194.7 (14.7)	326.1 (49.6)	236.6 (53.8)	228.1 (47.2)
Weight	127.4 (14.2)	-.84 (-20.3)			
Height	64.5 (2.5)	2.0 (8.4)			
Body mass	27.5 (2.4)		-4.0 (-20.9)		
Percentile	43.2 (20.5)			-.46 (-21.1)	
P(i to j)					Shown in table 9
Age	20.4 (2.2)	.88 (4.3)	.85 (4.1)	.82 (4.0)	.93 (4.5)
Race	.73 (.44)	-6.1 (-6.0)	-6.3 (-6.2)	-6.3 (-6.2)	-6.4 (-6.3)
Nmonths	5.6 (3.4)	-2.1 (-14.8)	-2.1 (-14.7)	-2.1 (-14.7)	-2.1 (-14.8)
Time	2.5 (1.6)	2.0 (6.9)	2.0 (6.9)	2.0 (6.9)	2.0 (6.8)
R ²		.11	.11	.11	.11
F-statistic		143.6	170.1	171.4	49.3

NOTE: Mean and standard deviation of PFT score are 222.1 and 40.3, respectively.

a. The independent variables are defined in table 5.

this result in the proper perspective, tables 8 and 9 show the effect of a two-standard-deviation change in the independent variables on the PFT score for males and females, respectively. For the male age variable, a change from one standard deviation below the mean to one standard deviation above the mean equals 3.4 years (i.e., from 18.2 to 21.6 years old). The PFT score increases by less than one point in response to this change in age. Similarly, when the age of females changes 4.4 years from 18.2 to 22.6, the effect on PFT is small, ranging from 3.6 to 4.1 points. For both males and females, the effect on PFT of a two-standard-deviation change in age is less than that of any other variable in the model. Moreover, given the small degree of variation in age, the positive relationship between age and PFT is strictly valid for relatively young Marines. Although it would be valid to argue that 22-year-olds would perform slightly better on the test than 18-year-olds, one cannot use these results to predict the PFT scores of 35-year-olds relative to 18-year-olds. Evidence from other studies indicates that age has a negative effect on physical fitness when the sample covers a broader range of ages. For example, reference [8] shows that age has a negative effect on performance on the Navy's PFT. Their sample consists of 1,357 Navy men ranging in age from 18 to 51 with a mean of 26.0 and a standard deviation of 6.2.

Table 8. Male comparative static analysis

Independent variable	Change of two standard deviations	Effect of change on PFT score
Body mass	6.0 kg/m ²	-13.8
Percentile of body mass	55.0 percentiles	-13.2
Age	3.4 years	.1 to .7
Nmonths	6.8 months	-8.8
Time	3.2 years	5.8 to 6.4

Table 9. Female comparative static analysis

Independent variable	Change of two standard deviations	Effect of change on PFT score
Body mass	4.8 kg/m ^{1.5}	-19.2
Percentile of body mass	41.0 percentiles	-18.9
Age	4.4 years	3.6 to 4.1
Nmonths	6.8 months	-14.3
Time	3.2 years	6.4

Tables 8 and 9 clearly demonstrate that body mass has the largest effect on the PFT score. With an increase of two standard deviations in body mass, PFT scores decline 13.8 points for males and 19.2 points for females. A two-standard-deviation change in percentile of body mass has a similar effect, with PFT scores declining 13.2 points for males and 18.9 points for females. The estimated effect of body mass on PFT scores may be understated to the extent that Marines who should be receiving unsatisfactory scores do not have those scores recorded, retake the PFT until they receive a satisfactory score, or separate before taking the test.

Test scores have increased over the sample time period about 2 points per fiscal year for both males and females. Thus, more recent cohorts of Marines are more physically fit than earlier cohorts. Relative to the beginning of training, test scores decline if the test is taken later at the rate of 1.3 points per month for males and 2.1 points per month for females. These results suggest that either physical fitness declines after boot camp or less physically fit Marines delay in taking their first PFT.

The fourth specification of the model decomposes the sample into 20 groups, with each group corresponding to five percentile points in the distribution of body mass. This equation allows for a nonlinear relationship between the PFT score and percentiles of body mass. The coefficient of each of the 19 dummy variables in the model is an estimate of the difference in PFT scores between that percentile group and the bottom 5 percent in body mass (i.e., the 1- to 5-percentile group, which acts as the control group). Table 10 summarizes the results from the fourth specification.

Comparing the 6- to 10-percentile group to the control group, physical fitness is shown to increase for both males and females. As body mass increases, physical fitness quickly reaches an interval where it falls and generally continues to decrease. Using the control group as a point of reference, males first perform significantly worse than this group at the 61- to 65-percentile interval. Females, however, initially perform significantly worse than the control group at the 26- to 30-percentile interval. Although test scores cannot be compared across genders, the fact that significant reductions in physical fitness occur at a lower percentile for females than males suggests that maximum weight standards (based on physical fitness) may be set at a lower percentile for females than males. However, a definitive recommendation on this issue would require that both genders receive the same physical fitness test.

The highest PFT score is observed within the 31- to 35-percentile interval for males and the 16- to 20-percentile group for females. Because PFT scores are maximized with respect to body mass at body masses well below the 50th percentile, the ideal weight from the standpoint of physical fitness is well below the average civilian weight.

Table 10. Estimated differences in PFT scores

Percentiles of body mass		Estimated difference in PFT scores between test and control groups (t-statistic)			
Test group	Control group	Male		Female	
6-10	1-5	3.3	(5.9)	1.2	(.4)
11-15	1-5	3.1	(5.4)	-2.0	(-.7)
16-20	1-5	4.3	(7.4)	1.8	(.6)
21-25	1-5	4.0	(6.9)	-3.4	(-1.2)
26-30	1-5	3.6	(6.2)	-5.8	(-2.0)
31-35	1-5	4.4	(7.2)	-8.4	(-3.0)
36-40	1-5	3.7	(6.4)	-9.6	(-3.6)
41-45	1-5	2.3	(4.0)	-15.0	(-5.6)
46-50	1-5	2.1	(3.4)	-12.4	(-4.5)
51-55	1-5	.5	(.8)	-16.0	(-5.9)
56-60	1-5	.4	(.7)	-17.9	(-6.9)
61-65	1-5	-2.7	(-4.4)	-23.1	(-9.4)
66-70	1-5	-4.5	(-6.6)	-26.6	(-10.7)
71-75	1-5	-5.9	(-9.2)	-34.7	(-11.0)
76-80	1-5	-8.8	(-13.4)		
81-85	1-5	-12.2	(-17.9)		
86-90	1-5	-19.2	(-29.8)		
91-95	1-5	-26.7	(-42.3)		
96-100	1-5	-27.5	(-49.7)		

ALTERNATIVE HEIGHT-WEIGHT STANDARDS

This section compares the current accession and active duty height-weight standards used by the Marine Corps to a variety of alternative standards that either have been proposed to the military by various research organizations or have been derived from definitions of overweight used in the civilian sector.¹ Appendix B provides tables of each of the standards considered in this paper. For each gender and height, the corresponding weight standards are then translated into body mass standards in appendix C. The body mass standards are subsequently translated into percentile terms in appendix D using the conversion tables from appendix A. For ease of exposition, comparisons of alternative standards will be expressed in terms of percentiles of body mass.

1. References [9] and [10], respectively, contain the accession and active duty standards currently used by the Marine Corps. The current accession standards apply to non-prior-service applicants.

Maximum Weight Standards

Tables 11 and 12 summarize each of the maximum weight standards for males and females, respectively. Across all ages and heights, the maximum weight standards range from the 78th to 98th percentile for men and from the 65th to 95th percentile for women. For males, the previous section indicated that higher percentiles of body mass within this range are associated with lower predicted levels of physical fitness. Although most females in the Marine Corps have body masses no greater than the 75th percentile, a generally downward trend in physical fitness is clearly evident up to this percentile. It seems reasonable to assume that this trend continues beyond the 75th percentile for the female sample based on the evidence from the male sample. The negative relationship between physical fitness and body mass justifies the use of a maximum weight standard.

Table 11. Male maximum weight standards

Standard	Age group (years)	Body mass in percentiles at:	
		Heights of 60-78 inches	Median height of 69 inches
Marine Corps accession	16-20	95	95
	21-30	97	97
	31-35	96-97	96
	36-40	94-95	95
	41+	91	91
Marine Corps active duty	All	82-84	84
Defense Manpower Data Center	16-20	88-89	88
	21-24	91	91
	25-30	93-94	94
	31-35	96	96
	36+	96	96
National Center for Health Statistics			
Overweight	All	85	85
Severely overweight	All	95	95
Naval Health Research Center			
22% body fat	All	78-82	80
26% body fat	All	92-93	92
26% body fat	16-20	97-98	97
	21-24	96-97	96
	25-30	93-96	95
	31-35	91-94	92
	36-40	90-92	90

Table 12. Female maximum weight standards

Standard	Age group (years)	Body mass in percentiles at:	
		Heights of 58-72 inches	Median height of 64 inches
Marine Corps accession	16-20	65-76	66
	21-24	67-79	70
	25-30	73-82	75
	31-35	75-86	79
	36-40	83-88	83
	41+	82-87	82
Marine Corps active duty	All	65-76	66
Defense Manpower Data Center	16-20	84-85	84
	21-24	86-87	87
	25-30	89	89
	31-35	90-91	91
	36+	91-92	91
National Center for Health Statistics			
Overweight	All	85	85
Severely overweight	All	95	95
Adjusted NCHS			
Overweight	All	80	80
Severely overweight	All	90	90
Naval Health Research Center			
30% body fat	All	73-76	75
36% body fat	All	86-89	89
36% body fat	16-20	87-89	89
	21-24	87-89	89
	25-30	86-89	89
	31-35	86-89	88
	36-40	86-89	88

The National Institutes of Health (NIH) convened a conference on the health implications of obesity in 1985. In the conference's consensus development statement [11], a committee of medical professionals recommended weight reduction for persons with body weights 20 percent or more above desirable weights in the 1983 Metropolitan Life Insurance Company tables. In terms of body mass, they show that these standards are quite similar to the overweight standards developed by the National Center for Health Statistics (NCHS) in [7] using NHANES-II data. Under the NCHS standards, adults of any age are classified as overweight if they exceed the 85th percentile of body mass for the 20- to 29-year-old age group of their gender. Those exceeding the 95th percentile of body mass for their gender are categorized as severely overweight by NCHS. The NHANES-II data base is used in this study because it was designed to be representative of the U.S. population. Data from the Metropolitan Life Insurance Company is deficient because the persons in its sample are self-selected rather than randomly chosen from the population.

In reference [12], the Defense Manpower Data Center (DMDC) also used the NHANES-II data but instead proposed that maximum body masses be set at 120 percent of the mean body mass within each age group and gender. The DMDC standards tend to be more lenient than the overweight standards used by NCHS, especially for older persons. Maximum body masses under the DMDC standards range from the 88th to 96th percentile for males and from the 84th to 92nd percentile for females. The stricter standards for females are the result of a higher variance of body mass for females than males in the civilian population.

Relative to DMDC's standards, the Corps' current accession standards are even more lenient for males with percentiles of 91 to 97. Females, however, are subject to much stricter accession standards, with percentiles ranging from 65 to 88.¹ For males, the Marine Corps' active duty standards are actually stricter than the NCHS overweight standards, with percentiles ranging from 82 to 84. The female active duty standards are much stricter than the male active duty standards and exactly the same as the female accession standards for the 16- to 20-year-old age group. One could attempt to rationalize much stricter standards for females relative to males on the premise that significant reductions in physical fitness occur at a lower percentile for females than males.

Alternatively, one could adopt the NCHS standards for males and adjust the NCHS standards for females to take into account their higher variance in body mass. This could be accomplished by using a methodology similar, though not identical, to that employed by DMDC in

1. The Army essentially has the same accession height-weight standards for males as the Marine Corps. The only difference is that the maximum height for males is 80 inches in the Army and 78 inches in the Marine Corps.

developing its standards. For males, the 85th percentile of body mass is approximately 117.5 percent of median body mass. Multiplying the median of body mass for females by 117.5 percent generates a maximum body mass in the 80th percentile. This standard is denoted as the adjusted NCHS standard for females in table 12. The original NCHS standard for males is not affected by the adjustment in the female standard.

In references [13] and [14], the Naval Health Research Center (NHRC) proposes maximum weight standards based on Navy standards for body fat. When maximum body fat is set at 26 percent for males and 36 percent for females, the maximum weight standards adjusting for age correspond to body masses ranging from the 90th to 98th percentile for males and from the 86th to 89th percentile for females. To keep the maximum percentage body fat constant across ages, maximum body mass must decrease as age increases because percentage body fat increases with age, controlling for body mass. This is in sharp contrast to DMDC's age-adjusted standards where maximum body mass increases with age based on the rationale that body mass increases with age in the civilian population. Both the Marine Corps active duty standards and NCHS standards occupy an intermediate position in that maximum body mass is not affected by age.

The Navy has adopted NHRC height-weight standards that are not adjusted for age. The male accession standards are based on 26 percent body fat and yield body masses in the 92nd and 93rd percentiles. The female accession standards are based on 36 percent body fat and yield body masses in the 86th through 89th percentiles. In both cases, maximum weights exceed those defined by NCHS as overweight. Lowering body fat to 22 percent for males and 30 percent for females generates active duty standards that are stricter than the NCHS overweight standard. The percentiles range from 78 to 82 for males and from 73 to 76 for females. The Marine Corps body fat standards (18 percent for males and 26 percent for females) are even more restrictive than the Navy body fat standards. If the Marine Corps incorporated its body fat standards into its height-weight standards using the NHRC methodology, the eligible male population would dramatically decrease. Such a standard would be more restrictive than any other height-weight standard considered in this research memorandum. This result suggests that the Marine Corps should continue its current practice of testing for body fat only when Marines are overweight.

Tables 11 and 12 also show the percentile corresponding to the maximum weight and median height of each gender. Several maximum weight standards permitted body masses in excess of the adjusted NCHS overweight standards of the 85th percentile for males and the 80th percentile for females. For 20-year-old males of median height, they include DMDC's standards (88th percentile), the current accession standards

(95th percentile), and NHRC's 26-percent body fat standards (92nd percentile without adjusting for age and 97th percentile adjusting for age). For 20-year-old females of median height, DMDC's standards (84th percentile) and NHRC's 36-percent body fat standards (89th percentile with and without age adjustment) allow body masses in excess of the adjusted NCHS overweight standards.

For 20-year-old males, only NHRC's 22-percent body fat standards (80th percentile) and the current active duty standards (84th percentile) restrict body masses below the adjusted NCHS overweight standards (85th percentile). For 20-year-old females, the accession and active duty standards (66th percentile) and NHRC's 30-percent body fat standards (75th percentile) are stricter than the adjusted NCHS overweight standards (80th percentile).

Minimum Weight Standards

Table 10 demonstrated that males above the 60th percentile of body mass and females above the 25th percentile of body mass receive lower PFT scores than their counterparts in the bottom 5 percent of body mass. Because many Marines are above these percentiles but are not classified as overweight under any of the alternative standards, a case could be made for adopting a very low minimum weight standard. Table 13 shows the minimum weight standards that have been proposed. The minimum weight standards are currently the same for accessions and active duty personnel. DMDC has alternatively proposed that minimum weights be set at 80 percent of mean body mass. The less restrictive minimum weight standards of DMDC would be superior (based on physical fitness) to the current standards. However, approximately one-half of 1 percent of the recruits of each gender in the sample would have been ineligible under the DMDC minimum weight standards. If minimum weight standards are used, both eligibility and physical fitness considerations would dictate a continuation of the current waiver policy for recruits below the minimum weights.

Table 13. Minimum weight standards

Standard	Gender	Body mass in percentiles at:	
		All heights	Median height
Marine Corps accession and active duty	Male	1 to 7	1
	Female	3 to 5	3
Defense Manpower Data Center	Male	1	1
	Female	2	2

IMPLICATIONS OF MAXIMUM WEIGHT STANDARDS ON PHYSICAL FITNESS

Tables 14 and 15 compare the effects of alternative standards on physical fitness for 20-year-old males and females. Using the first specification of the model, PFT scores are predicted at the median height of each gender and at the mean of Nmonths, Time, and Race. Because the current maximum weight standards for females generally do not lead to the accession of females beyond the 75th percentile, the predicted PFT scores of females above the 75th percentile are based on coefficients estimated from data on females below the 75th percentile.

To be classified as first class on the PFT, the minimum score is 225 for males and 200 for females. For each of the standards, with the exception of the NHRC age-adjusted 26-percent body fat standard, the typical male at the maximum weight would likely be categorized as first class on the PFT. For females, the current Marine Corps accession and active duty standards, the NHRC 26-percent body fat standard, and the adjusted NCHS standard would yield predicted PFT scores consistent with the first class. The remaining six standards have maximum weights that exceed those of the adjusted NCHS standard. In each case, they yield second class PFT scores at the maximum weight.

CONCLUSIONS

Direct comparisons of physical fitness across genders are infeasible because males and females are given different tests. The Army and Navy use the same test for both genders but subject males to stricter standards. If physical fitness is to be compared across genders, the Marine Corps could adopt one of these other tests. Using the same test as other services does not preclude the Corps from establishing its own minimum standards of physical fitness.

The regression analysis demonstrated that physical fitness test scores tend to decrease with increases in body mass or weight for both genders. PFT scores are maximized at weights below the average civilian weight for each gender. The decrease in physical fitness with respect to body mass over the middle and upper end of the distribution justifies the use of a maximum weight standard.

Maximum weight standards corresponding to higher percentiles of body mass will create a larger pool of potential recruits at the cost of a lower level of physical fitness. This memorandum predicts the PFT scores of Marines of median height at the maximum weight of each standard at about six months into their first term of service. If a first class PFT score is desired for this type of Marine, the accession weight standards should be no greater than the 95th percentile for males (NCHS standard for severely overweight males) and the 80th percentile for females (adjusted NCHS standard for overweight females). In selecting the maximum weight standard, policymakers should consider the tradeoff between physical fitness and applicant eligibility. Other factors

Table 14. Effect of maximum weights on physical fitness (20-year-old males at median height of 69 inches)

Standard	Maximum weight (pounds)	Corresponding percentile of body mass	Predicted PFT score at maximum weight	Category
NHRC (22% body fat)	182	80	236.4	1st class
Marine Corps active duty	186	84	235.0	1st class
NCHS (overweight)	188	85	234.3	1st class
DMDC (120% of mean body mass)	192	88	232.9	1st class
NHRC (26% body fat)	203	92	229.1	1st class
Marine Corps accession	209	95	227.0	1st class
NCHS (severely overweight)	210	95	226.6	1st class
NHRC (age-adjusted 26% body fat)	219	97	223.5	2nd class

Table 15. Effect of maximum weights on physical fitness (20-year-old females at median height of 64 inches)

Standard	Maximum weight (pounds)	Corresponding percentile of body mass	Predicted PFT score at maximum weight	Category
Marine Corps accession	138	66	213.1	1st class
Marine Corps active duty	138	66	213.1	1st class
NHRC (30% body fat)	145	75	207.2	1st class
Adjusted NCHS (overweight)	152	80	201.4	1st class
DMDC (120% of mean body mass)	157	84	197.2	2nd class
NCHS (overweight)	159	85	195.5	2nd class
NHRC (36% body fat)	166	89	189.6	2nd class
NHRC (age-adjusted 36% body fat)	167	89	188.8	2nd class
Adjusted NCHS (severely overweight)	170	90	186.2	2nd class
NCHS (severely overweight)	189	95	170.3	2nd class

affecting this decision, such as first-term attrition and applicant eligibility within specific age groups, will be explored in forthcoming memorandums.

Relative to Marines in the 1st through 5th percentiles of body mass, significant reductions in physical fitness were not observed until the 61- to 65-percentile group for males and the 26- to 30-percentile group for females. Because neither of these groups would be classified as overweight under any of the proposed standards, the average fitness of Marines in the bottom five percentiles is better than that of many heavier Marines with clearly acceptable weights. Based on physical fitness, minimum weight standards could be reduced slightly with a continuation of present waiver policies.

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APPENDIX A
CONVERSION TABLES

Table A-1. Conversion of body mass to percentiles
(male)

Percentile	Body mass	Percentile	Body mass
1	17.85	51	23.74
2	18.48	52	23.84
3	18.87	53	23.91
4	19.15	54	24.00
5	19.35	55	24.11
6	19.52	56	24.20
7	19.73	57	24.29
8	19.87	58	24.39
9	20.06	59	24.50
10	20.20	60	24.56
11	20.28	61	24.71
12	20.40	62	24.82
13	20.53	63	24.88
14	20.66	64	25.00
15	20.69	65	25.10
16	20.82	66	25.21
17	20.95	67	25.29
18	21.01	68	25.40
19	21.15	69	25.50
20	21.23	70	25.61
21	21.34	71	25.68
22	21.43	72	25.83
23	21.50	73	26.02
24	21.60	74	26.09
25	21.64	75	26.23
26	21.75	76	26.30
27	21.81	77	26.39
28	21.86	78	26.61
29	21.97	79	26.78
30	22.07	80	26.95
31	22.12	81	27.10
32	22.17	82	27.24
33	22.24	83	27.40
34	22.30	84	27.50
35	22.42	85	27.79
36	22.50	86	27.92
37	22.57	87	28.14
38	22.63	88	28.38
39	22.69	89	28.59
40	22.86	90	29.16
41	22.94	91	29.64
42	23.03	92	30.07
43	23.13	93	30.40
44	23.18	94	30.69
45	23.26	95	31.06
46	23.35	96	31.63
47	23.42	97	32.76
48	23.54	98	34.86
49	23.59	99	35.91
50	23.66	100	53.03

Table A-2. Conversion of body mass to percentiles
(female)

Percentile	Body mass	Percentile	Body mass
1	21.19	51	28.34
2	21.92	52	28.44
3	22.33	53	28.56
4	22.77	54	28.68
5	22.98	55	28.77
6	23.28	56	28.88
7	23.37	57	28.98
8	23.66	58	29.10
9	23.84	59	29.21
10	23.95	60	29.30
11	24.08	61	29.42
12	24.16	62	29.51
13	24.28	63	29.69
14	24.39	64	29.79
15	24.56	65	29.97
16	24.71	66	30.26
17	24.82	67	30.40
18	24.94	68	30.52
19	25.04	69	30.64
20	25.15	70	30.89
21	25.29	71	31.07
22	25.39	72	31.27
23	25.47	73	31.49
24	25.52	74	31.71
25	25.66	75	31.94
26	25.76	76	32.13
27	25.85	77	32.40
28	25.92	78	32.64
29	26.08	79	32.98
30	26.16	80	33.20
31	26.26	81	33.41
32	26.37	82	33.74
33	26.50	83	34.20
34	26.61	84	34.47
35	26.68	85	34.80
36	26.81	86	35.28
37	26.97	87	35.78
38	27.08	88	36.23
39	27.17	89	37.04
40	27.28	90	37.38
41	27.36	91	38.44
42	27.54	92	38.95
43	27.62	93	39.63
44	27.68	94	40.45
45	27.79	95	41.34
46	27.86	96	42.47
47	27.99	97	44.85
48	28.11	98	47.08
49	28.20	99	51.31
50	28.26	100	67.31

APPENDIX B
HEIGHT-WEIGHT STANDARDS

Table B-1. Marine Corps accession height-weight standards
(male)

Height (inches)	Minimum Weight (pounds)	Maximum weight (pounds) by age group				
		16-20 years	21-30 years	31-35 years	36-40 years	41 years and over
60	100	158	163	162	157	150
61	102	163	168	167	162	155
62	103	168	174	173	168	160
63	104	174	180	178	173	165
64	105	179	185	184	179	171
65	106	185	191	190	184	176
66	107	191	197	196	190	182
67	111	197	203	202	196	187
68	115	203	209	208	202	193
69	119	209	215	214	208	198
70	123	215	222	220	214	204
71	127	221	228	227	220	210
72	131	227	234	233	226	216
73	135	233	241	240	233	222
74	139	240	248	246	239	228
75	143	246	254	253	246	234
76	147	253	261	260	252	241
77	151	260	268	266	259	247
78	153	267	275	273	266	254

Table B-2. Marine Corps accession height-weight standards (female)

Height (inches)	Minimum Weight (pounds)	Maximum weight (pounds) by age group					
		16-20 years	21-24 years	25-30 years	31-35 years	36-40 years	41 years and over
58	90	121	123	124	126	135	135
59	92	123	125	129	129	139	138
60	94	125	127	132	132	142	141
61	96	127	129	135	135	145	147
62	98	130	132	139	141	148	147
63	100	134	137	141	145	151	150
64	102	138	141	145	150	156	154
65	104	142	145	149	155	161	159
66	106	147	150	154	160	165	164
67	109	151	155	159	165	171	169
68	112	156	159	163	169	176	174
69	115	160	164	168	175	181	179
70	118	165	169	173	180	186	184
71	122	170	174	178	185	192	190
72	125	175	178	183	190	197	195

Table B-3. Marine Corps active
duty height-weight standards
(male)

Height (inches)	<u>Weight (pounds)</u>	
	Minimum	Maximum
60	100	140
61	102	145
62	103	150
63	104	155
64	105	160
65	106	165
66	107	170
67	111	175
68	115	181
69	119	186
70	123	192
71	127	197
72	131	203
73	135	209
74	139	214
75	143	219
76	147	225
77	151	230
78	153	235

Table B-4. Marine Corps active
duty weight-height standards
(female)

Height (inches)	<u>Weight (pounds)</u>	
	Minimum	Maximum
58	90	121
59	92	123
60	94	125
61	96	127
62	98	130
63	100	134
64	102	138
65	104	142
66	106	147
67	109	151
68	112	156
69	115	160
70	118	165
71	122	170
72	125	175

Table B-5. DMDC height-weight standards (male)

Height (inches)	Minimum Weight (pounds)	Maximum weight (pounds) by age group				
		16-20 years	21-24 years	25-30 years	31-35 years	36 years and over
58 ^a	84	136	141	145	150	150
59 ^a	87	141	146	151	155	155
60	90	145	151	156	161	161
61	93	150	156	161	166	166
62	96	155	161	166	172	172
63	99	160	166	172	177	177
64	102	166	171	177	183	183
65	106	171	177	183	189	189
66	109	176	182	188	195	195
67	112	181	188	194	201	201
68	116	187	194	200	207	207
69	119	192	199	206	213	213
70	122	198	205	212	219	219
71	126	204	211	218	225	225
72	130	210	217	224	232	232
73	133	216	223	231	238	238
74	137	221	229	237	245	245
75	141	228	236	244	252	252
76	144	234	242	250	258	258
77	148	240	248	257	265	265
78	152	246	255	263	272	272
79 ^a	156	252	261	270	279	279
80 ^a	160	259	268	277	286	286

a. Height does not satisfy current Marine Corps standards.

Table B-6. DMDC height-weight standards (female)

Height (inches)	Minimum Weight (pounds)	Maximum weight (pounds) by age group				
		16-20 years	21-24 years	25-30 years	31-35 years	36 years and over
58	85	136	139	143	147	151
59	87	139	143	147	151	155
60	90	143	147	151	155	159
61	92	146	150	155	159	163
62	94	150	154	159	163	167
63	96	153	158	162	167	171
64	99	157	162	166	171	175
65	101	161	166	170	175	180
66	103	165	169	174	179	184
67	106	168	173	178	183	188
68	108	172	177	182	187	192
69	110	176	181	186	191	196
70	113	180	185	190	196	201
71	115	184	189	194	200	205
72	118	188	193	199	204	209
73 ^a	120	192	197	203	208	214
74 ^a	123	195	201	207	213	218
75 ^a	125	199	205	211	217	223
76 ^a	128	203	209	215	221	227
77 ^a	130	208	214	220	226	232
78 ^a	133	212	218	224	230	236
79 ^a	135	216	222	228	234	241
80 ^a	138	220	226	233	239	245

a. Height does not satisfy current Marine Corps standards.

Table B-7. NCHS height-weight standards
(male)

Height (inches)	Maximum weight (pounds)	
	85th percentile	95th percentile
58 ^a	133	149
59 ^a	138	154
60	142	159
61	147	164
62	152	170
63	157	175
64	162	181
65	167	187
66	172	192
67	177	198
68	183	204
69	188	210
70	194	216
71	199	223
72	205	229
73	211	235
74	216	242
75	222	248
76	228	255
77	234	262
78	240	269
79 ^a	247	276
80 ^a	253	283

a. Height does not satisfy current Marine
Corps standards.

Table B-8. NCHS height-weight standards
(female)

Height (inches)	Maximum weight (pounds)	
	85th percentile	95th percentile
58	137	163
59	141	167
60	144	171
61	148	176
62	152	180
63	155	184
64	159	189
65	163	193
66	167	198
67	170	202
68	174	207
69	178	211
70	182	216
71	186	221
72	190	225
73 ^a	194	230
74 ^a	198	235
75 ^a	202	240
76 ^a	206	244
77 ^a	210	249
78 ^a	214	254
79 ^a	218	259
80 ^a	222	264

a. Height does not satisfy current Marine
Corps standards.

Table B-9. Adjusted NCHS height-weight standards (female)

Height (inches)	Maximum weight (pounds)	
	80th percentile	90th percentile
58	131	146
59	134	150
60	138	154
61	141	158
62	145	162
63	148	166
64	152	170
65	155	174
66	159	178
67	162	182
68	166	186
69	170	190
70	173	194
71	177	198
72	181	202
73 ^a	185	207
74 ^a	189	211
75 ^a	192	215
76 ^a	196	219
77 ^a	200	224
78 ^a	204	228
79 ^a	208	232
80 ^a	212	237

a. Height does not satisfy current Marine Corps standards.

Table B-10. NHRC height-weight standards (male)

Height (inches)	Maximum weight (pounds)	
	22% body fat	26% body fat
60	139	155
61	143	160
62	148	165
63	152	170
64	157	176
65	162	181
66	167	186
67	172	192
68	176	197
69	182	203
70	187	209
71	192	215
72	197	220
73	202	226
74	208	232
75	213	239
76	219	245
77	224	251
78	230	257

Table B-11. NHRC height-weight standards (female)

Height (inches)	Maximum weight (pounds)	
	30% body fat	36% body fat
58	124	144
59	127	148
60	131	151
61	135	155
62	138	159
63	142	162
64	145	166
65	149	169
66	153	173
67	156	177
68	160	180
69	163	184
70	167	187
71	171	191
72	175	195
73 ^a	178	198
74 ^a	181	202
75 ^a	185	205
76 ^a	189	209
77 ^a	192	213
78 ^a	196	216

a. Height does not satisfy current
Marine Corps standards.

Table B-12. NHRC height-weight standards adjusted
for age: 26 percent body fat (male)

Height (inches)	Maximum weight (pounds) by age group				
	16-20 years	21-24 years	25-30 years	31-35 years	36-40 years
60	168	164	160	156	152
61	174	170	165	161	157
62	179	175	171	166	162
63	184	180	176	171	167
64	190	186	181	176	172
65	196	191	186	181	177
66	201	197	192	186	182
67	207	202	197	192	187
68	213	208	203	197	192
69	219	214	208	203	197
70	225	220	214	208	203
71	231	225	220	214	208
72	237	231	226	219	214
73	243	238	232	225	219
74	249	244	238	231	225
75	256	250	244	237	231
76	262	256	250	243	237
77	269	262	256	249	243
78	275	269	262	255	248

Table B-13. NHRC height-weight standards adjusted for age: 36 percent body fat (female)

Height (inches)	Maximum weight (pounds) by age group				
	16-20 years	21-24 years	25-30 years	31-35 years	36-40 years
58	145	145	144	144	143
59	149	148	148	147	147
60	152	152	151	151	150
61	156	156	155	154	154
62	160	159	159	158	158
63	163	163	162	162	161
64	167	166	166	165	165
65	170	170	169	169	168
66	174	174	173	172	172
67	178	177	177	176	176
68	181	181	180	180	179
69	185	184	184	183	183
70	188	188	188	187	186
71	192	192	191	191	190
72	196	195	195	194	194
73 ^a	199	199	198	198	197
74 ^a	203	202	202	201	201
75 ^a	207	206	206	205	204
76 ^a	210	210	209	209	208
77 ^a	214	213	213	212	212
78 ^a	217	217	216	216	215

a. Height does not satisfy current Marine Corps standards.

APPENDIX C
HEIGHT-MASS STANDARDS

Table C-1. Marine Corps accession height-mass standards
(male)

Height (inches)	Minimum body mass	Maximum body mass by age group				
		16-20 years	21-30 years	31-35 years	36-40 years	41 years and over
60	19.53	30.86	31.83	31.64	30.66	29.29
61	19.27	30.80	31.74	31.55	30.61	29.29
62	18.84	30.73	31.82	31.64	30.73	29.26
63	18.42	30.82	31.89	31.53	30.65	29.23
64	18.02	30.73	31.76	31.58	30.73	29.35
65	17.64	30.79	31.78	31.62	30.62	29.29
66	17.27	30.83	31.80	31.64	30.67	29.38
67	17.38	30.85	31.79	31.64	30.70	29.29
68	17.49	30.87	31.78	31.63	30.71	29.35
69	17.57	30.86	31.75	31.60	30.72	29.24
70	17.65	30.85	31.85	31.57	30.71	29.27
71	17.71	30.82	31.80	31.66	30.68	29.29
72	17.77	30.79	31.74	31.60	30.65	29.29
73	17.81	30.74	31.80	31.66	30.74	29.29
74	17.85	30.81	31.84	31.58	30.69	29.27
75	17.87	30.75	31.75	31.62	30.75	29.25
76	17.89	30.80	31.77	31.65	30.67	29.34
77	17.91	30.83	31.78	31.54	30.71	29.29
78	17.68	30.85	31.78	31.55	30.74	29.35

Table C-2. Marine Corps accession height-mass standards (female)

Height (inches)	Minimum body mass	Maximum body mass by age group					
		16-20 years	21-24 years	25-30 years	31-35 years	36-40 years	41 years and over
58	22.3	30.69	31.20	31.46	31.96	34.25	34.25
59	22.75	30.41	30.91	31.90	31.90	34.37	34.12
60	22.66	30.14	30.62	31.82	31.82	34.24	33.99
61	22.58	29.87	30.34	31.75	31.99	34.10	34.57
62	22.49	29.84	30.30	31.90	32.36	33.97	33.74
63	22.41	30.03	30.70	31.60	32.49	33.84	33.61
64	22.32	30.20	30.86	31.73	32.83	34.14	33.70
65	22.24	30.36	31.00	31.86	33.14	34.43	34.00
66	22.15	30.72	31.35	32.18	33.44	34.48	34.27
67	22.27	30.85	31.67	32.49	33.71	34.94	34.53
68	22.38	31.17	31.77	32.57	33.77	35.17	34.77
69	22.48	31.28	32.06	32.84	34.21	35.39	34.99
70	22.58	31.57	32.33	33.10	34.44	35.59	35.20
71	22.85	31.84	32.59	33.34	34.65	35.96	35.59
72	22.93	32.10	32.65	33.56	34.85	36.13	35.76

Table C-3. Marine Corps active
duty height-mass standards
(male)

Height (inches)	Minimum body mass	Maximum body mass
60	19.53	27.34
61	19.27	27.40
62	18.84	27.44
63	18.42	27.46
64	18.02	27.46
65	17.64	27.46
66	17.27	27.44
67	17.38	27.41
68	17.49	27.52
69	17.57	27.47
70	17.65	27.55
71	17.71	27.48
72	17.77	27.53
73	17.81	27.57
74	17.85	27.48
75	17.87	27.37
76	17.89	27.39
77	17.91	27.27
78	17.68	27.16

Table C-4. Marine Corps active
duty height-mass standards
(female)

<u>Height</u> <u>(inches)</u>	<u>Minimum</u> <u>body mass</u>	<u>Maximum</u> <u>body mass</u>
58	22.83	30.69
59	22.75	30.41
60	22.66	30.14
61	22.58	29.87
62	22.49	29.84
63	22.41	30.03
64	22.32	30.20
65	22.24	30.36
66	22.15	30.72
67	22.27	30.85
68	22.38	31.17
69	22.48	31.28
70	22.58	31.57
71	22.85	31.84
72	22.93	32.10

Table G-5. DMDC height-mass standards (male)

Height (inches)	Minimum body mass	Maximum body mass by age group				
		16-20 years	21-24 years	25-30 years	31-35 years	36 years and over
58 ^a	17.56	28.42	29.47	30.30	31.35	31.35
59 ^a	17.57	28.48	29.49	30.50	31.31	31.31
60	17.58	28.32	29.49	30.47	31.44	31.44
61	17.57	28.34	29.48	30.42	31.37	31.37
62	17.56	28.35	29.45	30.36	31.46	31.46
63	17.54	28.34	29.41	30.47	31.35	31.35
64	17.51	28.49	29.35	30.38	31.41	31.41
65	17.64	28.46	29.45	30.45	31.45	31.45
66	17.59	28.41	29.38	30.34	31.47	31.47
67	17.54	28.35	29.44	30.38	31.48	31.48
68	17.64	28.43	29.50	30.41	31.47	31.47
69	17.57	28.35	29.39	30.42	31.45	31.45
70	17.51	28.41	29.41	30.42	31.42	31.42
71	17.57	28.45	29.43	30.40	31.38	31.38
72	17.63	28.48	29.43	30.38	31.46	31.46
73	17.55	28.50	29.42	30.48	31.40	31.40
74	17.59	28.37	29.40	30.43	31.46	31.46
75	17.62	28.50	29.50	30.50	31.50	31.50
76	17.53	28.48	29.46	30.43	31.40	31.40
77	17.55	28.46	29.41	30.48	31.42	31.42
78	17.57	28.43	29.47	30.39	31.43	31.43
79 ^a	17.57	28.39	29.40	30.42	31.43	31.43
80 ^a	17.58	28.45	29.44	30.43	31.42	31.42

a. Height does not satisfy current Marine Corps standards.

Table C-6. DMDC height-mass standards (female)

Height (inches)	Minimum body mass	Maximum body mass by age group				
		16-20 years	21-24 years	25-30 years	31-35 years	36 years and over
58	21.56	34.50	35.26	36.28	37.29	38.30
59	21.51	34.37	35.36	36.35	37.34	38.32
60	21.70	34.48	35.44	36.41	37.37	38.33
61	21.64	34.34	35.28	36.45	37.40	38.34
62	21.58	34.43	35.35	36.49	37.41	38.33
63	21.51	34.28	35.40	36.30	37.42	38.32
64	21.67	34.36	35.45	36.33	37.42	38.30
65	21.60	34.43	35.49	36.35	37.42	38.49
66	21.52	34.48	35.32	36.36	37.41	38.45
67	21.66	34.33	35.35	36.37	37.39	38.41
68	21.58	34.37	35.37	36.37	37.37	38.37
69	21.50	34.41	35.39	36.36	37.34	38.32
70	21.62	34.44	35.40	36.35	37.50	38.46
71	21.54	34.46	35.40	36.34	37.46	38.40
72	21.64	34.48	35.40	36.50	37.42	38.33
73 ^a	21.56	34.49	35.39	36.47	37.37	38.45
74 ^a	21.65	34.32	35.38	36.44	37.49	38.37
75 ^a	21.56	34.33	35.37	36.40	37.44	38.47
76 ^a	21.65	34.33	35.35	36.36	37.38	38.39
77 ^a	21.56	34.49	35.49	36.48	37.48	38.47
78 ^a	21.63	34.48	35.46	36.44	37.41	38.39
79 ^a	21.54	34.47	35.43	36.38	37.34	38.46
80 ^a	21.61	34.45	35.39	36.49	37.43	38.37

a. Height does not satisfy current Marine Corps standards.

Table C-7. NCHS height-mass standards (male)

Height (inches)	<u>Maximum body mass</u>	
	85th percentile	95th percentile
58 ^a	27.80	31.14
59 ^a	27.87	31.10
60	27.73	31.05
61	27.78	30.99
62	27.80	31.09
63	27.81	31.00
64	27.81	31.07
65	27.79	31.12
66	27.76	30.99
67	27.72	31.01
68	27.82	31.02
69	27.76	31.01
70	27.84	30.99
71	27.75	31.10
72	27.80	31.06
73	27.84	31.00
74	27.73	31.07
75	27.75	31.00
76	27.75	31.04
77	27.75	31.07
78	27.73	31.09
79 ^a	27.83	31.09
80 ^a	27.79	31.09

a. Height does not satisfy current Marine Corps standards.

Table C-8. NCHS height-mass standards
(female)

Height (inches)	Maximum body mass	
	85th percentile	95th percentile
58	34.75	41.35
59	34.86	41.29
60	34.72	41.23
61	34.81	41.39
62	34.89	41.31
63	34.73	41.23
64	34.80	41.36
65	34.85	41.27
66	34.90	41.38
67	34.73	41.27
68	34.77	41.36
69	34.80	41.25
70	34.82	41.33
71	34.84	41.39
72	34.85	41.27
73 ^a	34.85	41.32
74 ^a	34.85	41.37
75 ^a	34.85	41.40
76 ^a	34.84	41.27
77 ^a	34.83	41.29
78 ^a	34.81	41.32
79 ^a	34.79	41.33
80 ^a	34.76	41.34

a. Height does not satisfy current Marine
Corps standards.

Table C-9. Adjusted NCHS height-mass standards (female)

Height (inches)	Maximum body mass	
	80th percentile	90th percentile
58	33.23	37.04
59	33.13	37.09
60	33.27	37.13
61	33.16	37.16
62	33.28	37.18
63	33.16	37.20
64	33.27	37.20
65	33.14	37.20
66	33.23	37.20
67	33.10	37.19
68	33.17	37.17
69	33.23	37.14
70	33.10	37.12
71	33.15	37.08
72	33.20	37.05
73 ^a	33.24	37.19
74 ^a	33.27	37.14
75 ^a	33.12	37.09
76 ^a	33.15	37.04
77 ^a	33.17	37.15
78 ^a	33.18	37.09
79 ^a	33.19	37.02
80 ^a	33.20	37.11

a. Height does not satisfy current Marine Corps standards.

Table C-10. NHRC height-mass standards
(male)

Height (inches)	Maximum body mass	
	22% body fat	26% body fat
60	27.15	30.27
61	27.02	30.23
62	27.07	30.18
63	26.93	30.11
64	26.95	30.21
65	26.96	30.12
66	26.95	30.02
67	26.94	30.07
68	26.76	29.95
69	26.88	29.98
70	26.83	29.99
71	26.78	29.99
72	26.72	29.84
73	26.65	29.82
74	26.71	29.79
75	26.62	29.87
76	26.66	29.82
77	26.56	29.76
78	26.58	29.70

Table C-11. NHRC height-mass standards
(female)

Height (inches)	Maximum body mass	
	30% body fat	36% body fat
58	31.46	36.53
59	31.40	36.59
60	31.58	36.41
61	31.75	36.45
62	31.67	36.49
63	31.82	36.30
64	31.73	36.33
65	31.86	36.14
66	31.97	36.15
67	31.87	36.16
68	31.97	35.97
69	31.87	35.97
70	31.95	35.78
71	32.03	35.77
72	32.10	35.76
73 ^a	31.98	35.57
74 ^a	31.86	35.56
75 ^a	31.92	35.37
76 ^a	31.96	35.35
77 ^a	31.84	35.32
78 ^a	31.88	35.13

a. Height does not satisfy current
Marine Corps standards.

Table C-12. NHRC height-mass standards adjusted for age: 26% body fat (male)

Height (inches)	Maximum body mass by age group				
	16-20 years	21-24 years	25-30 years	31-35 years	36-40 years
60	32.81	32.03	31.25	30.47	29.69
61	32.88	32.12	31.18	30.42	29.66
62	32.74	32.01	31.28	30.36	29.63
63	32.59	31.89	31.18	30.29	29.58
64	32.61	31.93	31.07	30.21	29.52
65	32.62	31.78	30.95	30.12	29.45
66	32.44	31.80	30.99	30.02	29.38
67	32.42	31.64	30.85	30.07	29.29
68	32.39	31.63	30.87	29.95	29.19
69	32.34	31.60	30.72	29.98	29.09
70	32.28	31.57	30.71	29.84	29.13
71	32.22	31.38	30.68	29.85	29.01
72	32.14	31.33	30.65	29.70	29.02
73	32.06	31.40	30.61	29.69	28.89
74	31.97	31.33	30.56	29.66	28.89
75	32.00	31.25	30.50	29.62	28.87
76	31.89	31.16	30.43	29.58	28.85
77	31.90	31.07	30.36	29.53	28.82
78	31.78	31.09	30.28	29.47	28.66

Table G-13. NHRC height-mass standards adjusted for age: 36% body fat (female)

Height (inches)	Maximum body mass by age group				
	16-20 years	21-24 years	25-30 years	31-35 years	36-40 years
58	36.78	36.78	36.53	36.53	36.28
59	36.84	36.59	36.59	36.35	36.35
60	36.65	36.65	36.41	36.41	36.16
61	36.69	36.69	36.45	36.22	36.22
62	36.72	36.49	36.49	36.27	36.27
63	36.53	36.53	36.30	36.30	36.08
64	36.55	36.33	36.33	36.11	36.11
65	36.35	36.35	36.14	36.14	35.92
66	36.36	36.36	36.15	35.94	35.94
67	36.37	36.16	36.16	35.96	35.96
68	36.17	36.17	35.97	35.97	35.77
69	36.17	35.97	35.97	35.78	35.78
70	35.97	35.97	35.97	35.78	35.59
71	35.96	35.96	35.77	35.77	35.59
72	35.95	35.76	35.76	35.58	35.58
73 ^a	35.75	35.75	35.57	35.57	35.39
74 ^a	35.73	35.56	35.56	35.38	35.38
75 ^a	35.71	35.54	35.54	35.37	35.19
76 ^a	35.52	35.52	35.35	35.35	35.18
77 ^a	35.49	35.32	35.32	35.16	35.16
78 ^a	35.30	35.30	35.13	35.13	34.97

a. Height does not satisfy current Marine Corps standards.

APPENDIX D
HEIGHT-PERCENTILE STANDARDS

Table D-1. Marine Corps accession height-percentile standards (male)

Height (inches)	Minimum body mass in percentiles	Maximum body mass in percentiles by age group				
		16-20 years	21-30 years	31-35 years	36-40 years	41 years and over
60	7	95	97	97	94	91
61	5	95	97	96	94	91
62	3	95	97	97	95	91
63	2	95	97	96	94	91
64	2	95	97	96	95	91
65	1	95	97	96	94	91
66	1	95	97	97	94	91
67	1	95	97	97	95	91
68	1	95	97	96	95	91
69	1	95	97	96	95	91
70	1	95	97	96	95	91
71	1	95	97	97	94	91
72	1	95	97	96	94	91
73	1	95	97	97	95	91
74	1	95	97	96	94	91
75	2	95	97	96	95	91
76	2	95	97	97	94	91
77	2	95	97	96	95	91
78	1	95	97	96	95	91

Table D-2. Marine Corps accession height-percentile standards
(female)

Height (inches)	Minimum body mass in percentiles	Maximum body mass in percentiles by age group					
		16-20 years	21-24 years	25-30 years	31-35 years	36-40 years	41 years and over
58	5	70	72	73	76	84	84
59	4	68	71	75	75	84	83
60	4	66	69	75	75	84	83
61	4	65	67	75	76	83	85
62	4	65	67	75	77	83	82
63	4	66	70	74	78	83	82
64	3	66	70	75	79	83	82
65	3	67	71	75	80	84	83
66	3	70	73	77	82	85	84
67	3	70	74	78	82	86	85
68	4	72	75	78	83	86	85
69	4	73	76	79	84	87	86
70	4	74	77	80	84	87	86
71	5	75	78	81	85	88	87
72	5	76	79	82	86	88	87

Table D-3. Marine Corps active
duty height-percentile standards
(male)

Height (inches)	Body mass in percentiles	
	Minimum	Maximum
60	7	83
61	5	83
62	3	84
63	2	84
64	2	84
65	1	84
66	1	84
67	1	84
68	1	84
69	1	84
70	1	84
71	1	84
72	1	84
73	1	84
74	1	84
75	2	83
76	2	83
77	2	83
78	1	82

Table D-4. Marine Corps active
duty height-percentile standards
(female)

Height (inches)	Body mass in percentiles	
	Minimum	Maximum
58	5	70
59	4	68
60	4	66
61	4	65
62	4	65
63	4	66
64	3	66
65	3	67
66	3	70
67	3	70
68	4	72
69	4	73
70	4	74
71	5	75
72	5	76

Table D-5. DMDC height-percentile standards (male)

Height (inches)	Minimum body mass in percentiles	Maximum body mass in percentiles by age group				
		16-20 years	21-24 years	25-30 years	31-35 years	36 years and over
58 ^a	1	89	91	93	96	96
59 ^a	1	89	91	94	96	96
60	1	88	91	94	96	96
61	1	88	91	94	96	96
62	1	88	91	93	96	96
63	1	88	91	94	96	96
64	1	89	91	93	96	96
65	1	89	91	94	96	96
66	1	89	91	93	96	96
67	1	88	91	93	96	96
68	1	89	91	94	96	96
69	1	88	91	94	96	96
70	1	89	91	94	96	96
71	1	89	91	93	96	96
72	1	89	91	93	96	96
73	1	89	91	94	96	96
74	1	88	91	94	96	96
75	1	89	91	94	96	96
76	1	89	91	94	96	96
77	1	89	91	94	96	96
78	1	89	91	93	96	96
79 ^a	1	89	91	94	96	96
80 ^a	1	89	91	94	96	96

a. Height does not satisfy current Marine Corps standards.

Table D-6. DMDC height-percentile standards (female)

Height (inches)	Minimum body mass in percentiles	Maximum body mass in percentiles by age group				
		16-20 years	21-24 years	25-30 years	31-35 years	36 years and over
58	2	85	86	89	90	91
59	2	84	87	89	90	91
60	2	85	87	89	90	91
61	2	84	86	89	91	91
62	2	84	87	89	91	91
63	2	84	87	89	91	91
64	2	84	87	89	91	91
65	2	84	87	89	91	92
66	2	85	87	89	91	92
67	2	84	87	89	91	91
68	2	84	87	89	90	91
69	2	84	87	89	90	91
70	2	84	87	89	91	92
71	2	84	87	89	91	91
72	2	85	87	89	91	91
73 ^a	2	85	87	89	90	92
74 ^a	2	84	87	89	91	91
75 ^a	2	84	87	89	91	92
76 ^a	2	84	87	89	90	91
77 ^a	2	85	87	89	91	92
78 ^a	2	85	87	89	91	91
79 ^a	2	84	87	89	90	92
80 ^a	2	84	87	89	91	91

a. Height does not satisfy current Marine Corps standards.

Table D-7. NHRC height-percentile standards (male)

Height (inches)	Maximum body mass in percentiles	
	22% body fat	26% body fat
60	82	93
61	81	93
62	81	93
63	80	93
64	80	93
65	81	93
66	80	92
67	80	92
68	79	92
69	80	92
70	80	92
71	79	92
72	79	92
73	79	92
74	79	92
75	79	92
76	79	92
77	78	92
78	78	92

Table D-8. NHRC height-percentile standards (female)

Height (inches)	Maximum body mass in percentiles	
	30% body fat	36% body fat
58	73	89
59	73	89
60	74	89
61	75	89
62	74	89
63	75	89
64	75	89
65	75	88
66	76	88
67	75	88
68	76	88
69	75	88
70	76	87
71	76	87
72	76	87
73 ^a	76	87
74 ^a	75	87
75 ^a	75	87
76 ^a	76	87
77 ^a	75	87
78 ^a	75	86

a. Height does not satisfy current
Marine Corps standards.

Table D-9. NHRC height-percentile standards adjusted for age: 26 percent body fat (male)

Height (inches)	Maximum body mass in percentiles by age group				
	16-20 years	21-24 years	25-30 years	31-35 years	36-40 years
60	98	97	96	94	92
61	98	97	96	94	92
62	97	97	96	93	91
63	97	97	96	93	91
64	97	97	96	93	91
65	97	97	95	93	91
66	97	97	95	92	91
67	97	97	95	92	91
68	97	96	95	92	91
69	97	96	95	92	90
70	97	96	95	92	90
71	97	96	94	92	90
72	97	96	94	92	90
73	97	96	94	92	90
74	97	96	94	92	90
75	97	96	94	91	90
76	97	96	94	91	90
77	97	96	93	91	90
78	97	96	93	91	90

Table D-10. NHRC height-percentile standards adjusted for age: 36 percent body fat (female)

Height (inches)	Maximum body mass in percentiles by age group				
	16-20 years	21-24 years	25-30 years	31-35 years	36-40 years
58	89	89	89	89	89
59	89	89	89	89	89
60	89	89	89	89	88
61	89	89	89	88	88
62	89	89	89	88	89
63	89	89	89	88	88
64	89	89	89	88	88
65	89	89	88	88	88
66	89	89	88	88	88
67	89	88	88	88	88
68	88	88	88	88	87
69	88	88	88	87	87
70	88	88	88	87	87
71	88	88	87	87	87
72	88	87	87	87	87
73 ^a	87	87	87	87	87
74 ^a	87	87	87	87	87
75 ^a	87	87	87	87	86
76 ^a	87	87	87	87	86
77 ^a	87	87	87	86	86
78 ^a	87	87	86	86	86

a. Height does not satisfy current Marine Corps standards.